REMARKS

Applicants have amended their claims in order to further clarify the definition of various aspects of the present invention. Specifically, Claim 1 has been amended to recite that the abrasive includes the cerium oxide particles, a dispersant, water, and, additionally, the specified organic polymer. Claim 12 has been amended to recite that the additive includes an organic, rather than an inorganic, polymer.

In addition, applicants are adding new claims 13-22 to the application. Claims 13 and 14, dependent respectively on Claims 1 and 13, define amount of organic polymer included in the abrasive. Claim 15, dependent on Claim 1, defines a weight average molecular weight of the organic polymer. Claims 16, 18 and 20, dependent respectively on Claims 1, 10 and 12, recite that the film to be polished is an inorganic insulating film; and Claims 17, 19 and 21, dependent respectively on Claims 16, 18 and 20, recite that the inorganic insulating film is at least one of a silicon oxide film and a silicon nitride film. Claim 22, dependent on Claim 12, recites that the specified organic polymer is in addition to a dispersant included in the CMP abrasive.

In connection with amendments to previously considered claims, and in connection with the newly added claims, note, for example, pages 4-11 of applicants' Specification.

The objection to the disclosure as set forth in Item 1 on page 2 of the Office Action of February 25, 2004, is noted. Applicants have amended the paragraph bridging 3 and 4 of the Specification, to provide clarified wording. In view of the present amendments to the Specification, it is respectfully submitted that the required correction has been made, and the objection to the disclosure is *moot*.

The rejection of Claim 12 under the first paragraph of 35 USC §112, set forth in Item 3 on page 2 of the Office Action mailed February 25, 2004, is noted. Claim 12 has

been amended to recite that the additive includes an "organic", rather than inorganic, polymer. In view of this amendment to Claim 12, it is respectfully submitted that the rejection thereof under the first paragraph of 35 USC §112, is *moot*.

Applicants respectfully submit that all of the claims now presented for consideration by the Examiner patentably distinguish over the teachings of the references applied by the Examiner in rejecting claims in the Office Action mailed February 25, 2004, that is, the teachings of United States Patent Appln. Publication No. US2003/0181046 to Sachan, et al, and Japanese Patent Document No. 10-102040, under the provisions of 35 USC §102 and 35 USC §103.

It is respectfully submitted that these references as applied by the Examiner would have neither taught nor would have suggested such a CMP (Chemical Mechanical Polishing) abrasive as in the present claims, including, in addition to cerium oxide particles, a dispersant and water, an organic polymer having an atom or a structure capable of forming a hydrogen bond with a hydroxyl group present on a surface of a film to be polished. See Claim 1.

Moreover, it is respectfully submitted that these references as applied by the Examiner would have neither taught nor would have suggested such a method for polishing a substrate, or such a method for manufacturing a semiconductor device, as in the present claims, including a polishing step while supplying the aforementioned CMP abrasive referred to in connection with Claim 1, between a film to be polished and a polishing cloth. See Claim 10; note also Claim 11.

Furthermore, it is respectfully submitted that these applied references would have neither taught nor would have suggested such an additive for a CMP abrasive as in the present claims, including water and the recited organic polymer having an atom or a structure capable of forming a hydrogen bond with a hydroxyl group present on a

surface of a film to be polished. (see Claim 12); more specifically, wherein the organic polymer is in addition to a dispersant included in the CMP abrasive (see Claim 22).

Moreover, it is respectfully submitted that these references as applied by the Examiner would have neither taught nor would have suggested such CMP abrasive as in the present claims, having features as discussed previously in connection with Claim 1 and, moreover, further including (but not limited to) wherein the organic polymer is a compound containing at least one atom having an unpaired electron in a molecular structure (see Claim 2), or is a compound containing either one or both of a nitrogen atom and an oxygen atom in a molecular structure (see Claim 3), more specifically, wherein the organic polymer is polyvinyl pyrrolidone (see Claim 7), this polyvinyl pyrrolidone having a weight average molecular weight of 5,000 to 2,000,000 (See Claim 8); and/or wherein the sedimentation speed of cerium oxide particles of the abrasive is 20 μm/s or less (see Claim 6); and/or amounts of the organic polymer in the abrasive as in Claims 9, 13 and 14, especially amount of dispersant and of organic polymer, with the concentration of the cerium oxide particles in the abrasive being 0.5-20% by weight (see Claim 9); and/or weight average molecular weight of the organic polymer as in Claim 15; and/or the abrasive, polishing method or additive of the present claims, with the film to be polished being an inorganic insulating film (see Claims 16, 18 and 20), more specifically, wherein the inorganic insulating film is at least one of a silicon oxide film and a silicon nitride film (see Claims 17, 19 and 21).

The present invention relates to a CMP abrasive used in a step for smoothing a surface of a substrate, particularly for smoothing an insulating film (e.g., an interlayer insulating film), to a method for polishing a substrate and for manufacturing a semiconductor device using this CMP abrasive, and to an additive for the CMP abrasive.

With current ultra-large scale integrated circuits, having increased packaging density, CMP technology has become more important for fully smoothing (e.g., planarizing) a layer, especially for planarizing an interlayer insulating film and a BPSG (Boron Phosphorus-doped Silicon Dioxide) film and performing shallow trench isolation. With conventional CMP technology for smoothing an interlayer insulating film, technical problems arise in that a high-level of smoothing can not be realized over an entire surface of a wafer, as described on the first paragraph on page 2 of applicants' Specification.

Against this background, applicants provide a CMP abrasive and methods of use thereof, as well as additives therefor, capable of polishing a surface to be polished (in particular, an insulating film, such as a silicon oxide or silicon nitride insulating film) at high speed, without causing scratches, while achieving a high level of smoothing. Applicants have achieved these objectives, with a CMP abrasive according to the present invention, which also has excellent storage stability. Applicants have found that by including an organic polymer having an atom or a structure capable of forming a hydrogen bond with a hydroxyl group present on a surface of a film to be polished, together with, e.g., the dispersant and cerium oxide particles, and water, objectives according to the present invention are achieved. That is, a surface to be polished (in particular, an insulating film such as a silicon oxide film or silicon nitride film) can be polished with a high speed and a high level of smoothness, without scratches, achieving a manufactured product, using the polishing, in a high yield. In addition, the CMP abrasive according to the present invention has good storage stability. Note from page 24, line 31 to page 25, line 12, of applicants' Specification.

Illustrative of the advantages achieved according to the present invention, attention is respectfully directed to the Examples and Comparative Examples on

pages 13-24 of applicants' Specification. Note, in particular, Comparative Example 1 on pages 21-23 of applicants' Specification; it is respectfully submitted that this corresponds to the working Example of the applied Japanese Patent Document No. 10-102040. An English translation of this working Example is enclosed herewith. As can be seen in the polishing speed ratios R_5/R_1 and R_3/R_1 in the Examples and Comparative Examples (including the aforementioned Comparative Example 1) in the present Specification, these ratios were much closer to one for compositions according to the present invention (note Examples 1 and 2 on pages 13-21 of applicants' Specification), as compared with polishing speed ratios for Comparative Examples 1 and 2 on pages 21-24 of applicants' Specification. In particular, compare the polishing speed ratios for Examples 1 and 2, respectively set forth at page 18, lines 13-23 and page 20, line 26 to page 21, line 11; with the polishing speed ratios for Comparative Examples 1 and 2, respectively, at page 23, lines 7-20 and page 24, lines 13-20. As is clear from these Examples and Comparative Examples, unexpectedly better smoothing at higher polishing speeds, corresponding to the polishing speed ratios closer to 1, are achieved according to the present invention, including the organic polymer recited in the present claims, as compared with the Comparative Examples. It is respectfully submitted that this evidence of unexpectedly better results must be considered in determining patentability of the present invention (see ***In re DeBlauwe, 222 USPQ 191 (CAFC 1984));*** and, properly considered, it is respectfully submitted that this evidence of unexpectedly better results clearly supports a conclusion of unobviousness of the presently claimed subject matter.

The applied Japanese Patent Document discloses an abrasive which includes a slurry prepared by dispersing cerium oxide particles containing specific primary particles in a medium. The primary particles each have a profile with corners less than

120° in angle, and are dispersed in a medium that is water and a dispersant which is at least one kind selected from water-soluble organic polymers, water-soluble anionic surfactants, water-soluble nonionic surfactants and water-soluble amines.

It is respectfully submitted that the applied Japanese Patent Document does not disclose, nor would have suggested, such CMP abrasive, or such method of use thereof, or such additive therefor, as in the present claims, including the organic polymer having an atom or a structure capable of forming a hydrogen bond with a hydroxyl group present on a surface of a film to be polished; and, in particular, wherein such organic polymer is in addition to cerium oxide particles, a dispersant and water of the abrasive, and advantages achieved by this abrasive, method of use thereof and additive; or the other features of the present invention as discussed previously, and advantages thereof.

It is respectfully submitted that the combined teachings of Sachan, et al and the applied Japanese Patent Document would have neither disclosed nor would have suggested the presently claimed subject matter.

Sachan, et al discloses techniques for polishing and planarization of integrated circuit surfaces, particularly those comprising a metal, a barrier layer and an insulating layer. This patent is primarily directed to such polishing which attenuates removal of the oxide film during metal CMP. This patent discloses that by including one or more organic polymers which attenuate removal of the oxide film, the polymers having functional moieties interacting strongly with the silicon oxide surface so as to provide a protective layer that inhibits removal of the silicon dioxide film at appreciable levels, the metal and barrier layer can be polished without removal of the oxide film. Note paragraphs [0003] and [0013] - [0017] on pages 1 and 2 of Sachan, et al. This patent document further discloses that the slurries may optionally contain a dispersant, which

dispersant can be anionic, cationic or nonionic. See paragraph [0019] on page 2 of this published patent application.

The applied Japanese Patent Document has been previously discussed. It is emphasized that this patent document is concerned with polishing of the insulating film.

It is emphasized that Sachan, et al is concerned with polishing the metal and barrier layers, with attenuated removal of the oxide film. It is respectfully submitted that one of ordinary skill in the art concerned with in Sachan, et al, attenuating (avoiding) polishing of the insulating film, would not have looked to the teachings of the applied Japanese patent document (which polishes the insulating films).

Moreover, absent hindsight use of applicants' disclosure, which of course is improper under 35 USC §103, there would have been no motivation for combining the teachings of Sachan, et al and the Japanese Patent Document as applied by the Examiner.

In any event, even assuming, *arguendo,* that the teachings of the applied references were properly combinable, it is respectfully submitted that such combined teachings would have neither disclosed nor would have suggested the presently claimed subject matter, including wherein the abrasive contains the organic polymer in addition to the dispersant, and advantages thereof, including high speed polishing especially with respect to polishing insulating films such as silicon oxide and silicon nitride (in this regard, note especially Claims 16-21).

The contention by the Examiner in Item 5 on page 3 of the Office Action mailed February 25, 2004, that the applied Japanese Patent Document discloses a CMP

abrasive including, *inter alia*, an organic polymer as recited in the present claims, is respectfully traversed. As can be seen in the Abstract of the applied Japanese Patent Document, the medium in which the cerium oxide particles is provided includes water and the dispersant. It is respectfully submitted that this applied Japanese Patent Document does not disclose, nor would have suggested, an abrasive including the specified organic polymer, much less such organic polymer in addition to the dispersant, and advantages thereof.

The Examiner is respectfully requested to point out the description in the applied Japanese Patent Document (or abstract thereof) of "an organic polymer inherently having an atom or a structure capable of forming a hydrogen bond with a hydroxyl group present on a surface of a film to be polished", especially in addition to a dispersant.

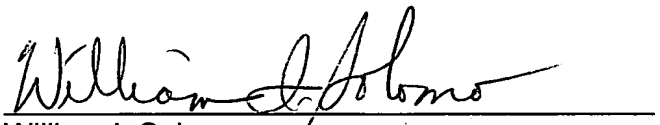
Applicants note with thanks the indication by the Examiner that the subject matter of Claims 4 and 5 would be allowable if set forth in independent form. As shown previously herein, it is respectfully submitted that the parent claim of Claims 4 and 5, that is, Claim 1, is allowable. Accordingly, it is respectfully submitted that Claims 4 and 5 should also be allowed, even without being set forth in independent form.

In view of the foregoing comments and amendments, reconsideration and allowance of all claims remaining in the application are respectfully requested.

To the extent necessary, applicants petition for an extension of time under 37 CFR §1.136. Please charge any shortage in the fees due in connection with the filing

of this paper, including Extension of Time fees, to the Deposit Account of Antonelli, Terry, Stout & Kraus, LLP, Dep. Acct. No. 01-2135 (511.40998X00), and please credit any excess fees to such deposit account.

Respectfully submitted,
ANTONELLI, TERRY, STOUT & KRAUS, LLP



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Enclosure: Partial English-language translation of JP 10-102040 (1 page).

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Partial English-language translation of JP 10-102040

[0017]
[Example]
(Preparation of cerium oxide particles) 600 g of cerium carbonate hydrate (99.9%) was placed into a vessel made of platinum, and calcined at a temperature of 800°C for 2 hours in the air to obtain yellowish white powder. This powder was phase-identified by an X-ray diffractometry, whereby the powder was confirmed to be cerium oxide. Moreover, by a transmittance type electron microscopic observation, primary particles were confirmed to be primary particles showing a profile with a corner smaller than 120°C. Also, by a transmittance electron microscopic observation, the primary particles were confirmed to be 100 nm or more and 300 nm or less.
[0018] (Preparation of cerium oxide slurry) 80 g of the above-mentioned cerium oxide powder was dispersed in 800 g of deionized water, and 8 g of ammonium polyacrylate was added to the dispersion, and then, the mixture was subjected to dispersion treatment using a planetary ball mill (manufactured by Fliche, trade name: Type P-5) at 2300 rpm for 30 minutes to obtain a milky which cerium oxide slurry. A pH of the slurry was 9.1. When grain size distribution of the slurry was examined (by Master Sizer), it could be found that an average particle size was as small as 270 nm, and a half value width thereof was relatively narrow distribution of 300 nm.
[0019] (Polishing of insulating film) A Si wafer on which a SiO_2 insulating film formed by the TEOS-plasma CVD method had been formed was set on a holder to which an adsorption pad for mounting a substrate to be held was adhered, and the holder was placed on a platen to which a polishing pad made of a porous urethane resin was adhered with the insulating film surface down, and then the working load was set to be 160 g/cm^2. The platen and the wafer were rotated for 3 minutes at a rotational speed of 30 rpm while dropping the above-mentioned cerium oxide slurry (solid content: 2.5% by weight) on the platen at a dropping speed of 35 cc/min, thereby polishing the insulating film. After polishing, the polished wafer was removed from the holder and washed well with flowing water, it was further washed with an ultrasonic wave washing machine for 20 minutes. After washing, water drops were removed from the wafer by a spin dryer and the wafer was dried in a dryer at 120°C for 10 minutes. By using a light-interference type film thickness measurement device, changes in film thickness before and after the polishing were measured. As a result, it could be understood that, 640 nm of the insulating film was removed by the polishing and the wafer had a uniform thickness at the whole surface. Also, there was no scratch on the surface of the insulating film by visual observation.
[0020] Comparative example
In the same manner as in Example, with regard to the Si wafer on which a SiO_2 insulating film formed by the TEOS-CVD method had been formed, polishing was carried out by using a commercially available silica slurry (available from Cabot Co., trade name: SS225). This commercially available slurry has a pH of 10.3 and contains 12.5% by weight of SiO_2 particles. The polishing conditions are the same as in Example. As a result, no scratch due to the polishing was observed and uniform polishing had been done, but only 75 nm of the insulating film was removed by the polishing for 3 minutes.
[0021]
[Effects of the invention] According to the abrasive of the present invention, it is possible to polish a surface to be polished such as a SiO_2 insulating film, etc., without scratches and with a high speed.